



Creating the Foundation for Embedded Media Processing

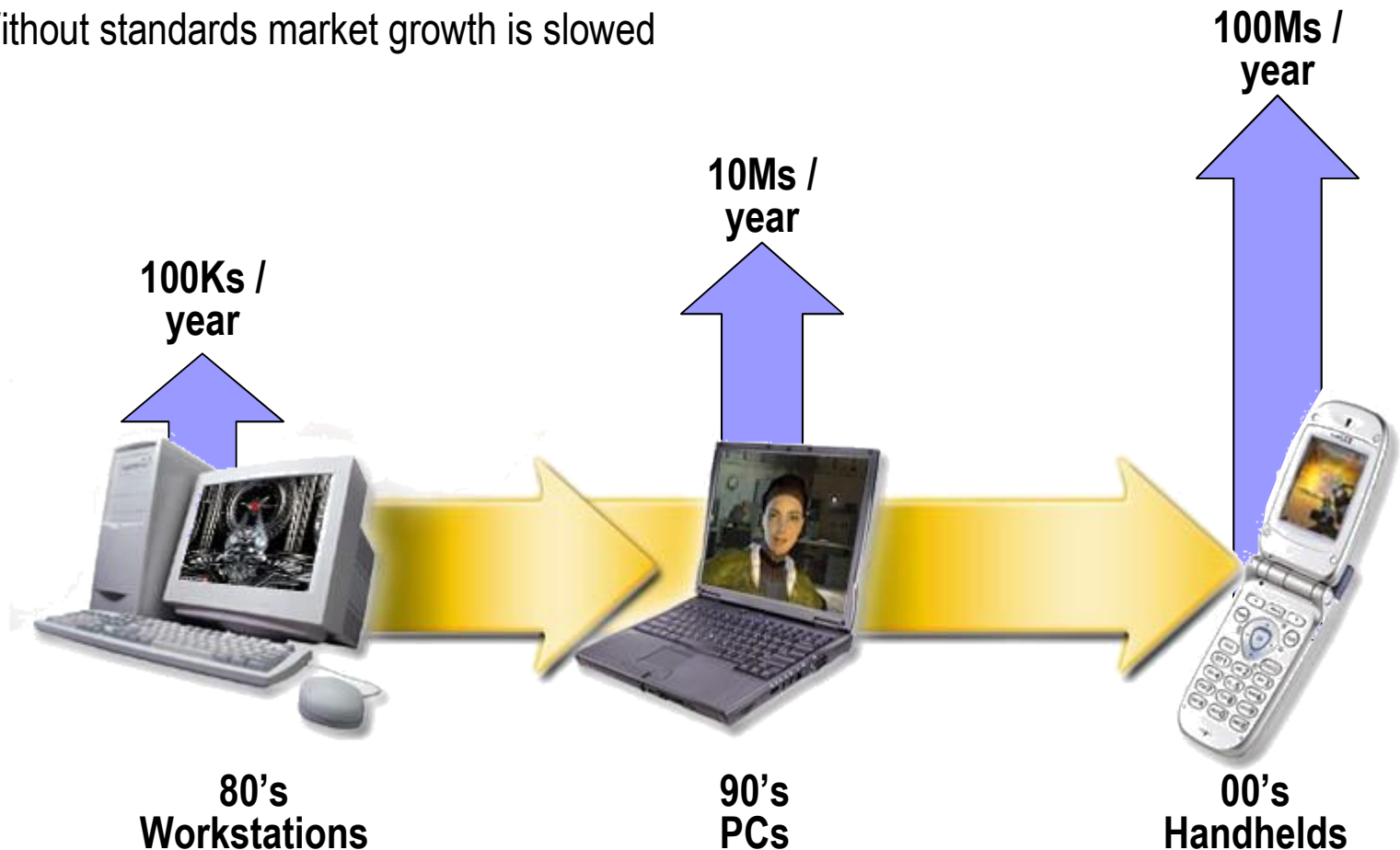
Ed Plowman
3D Graphics Product Manager, ARM
Promoter's Board Member, Khronos Group
Active Member Of OpenGL ES Working Group

Agenda

- The need for embedded media API standards
 - The mission and structure of the Khronos Group
 - Overview of the Khronos APIs
 - OpenGL ES – embedded 3D graphics
 - OpenVG – 2D vector graphics acceleration
 - OpenMAX – making media codecs and libraries portable
 - Questions
-
- These slides are available at www.khronos.org

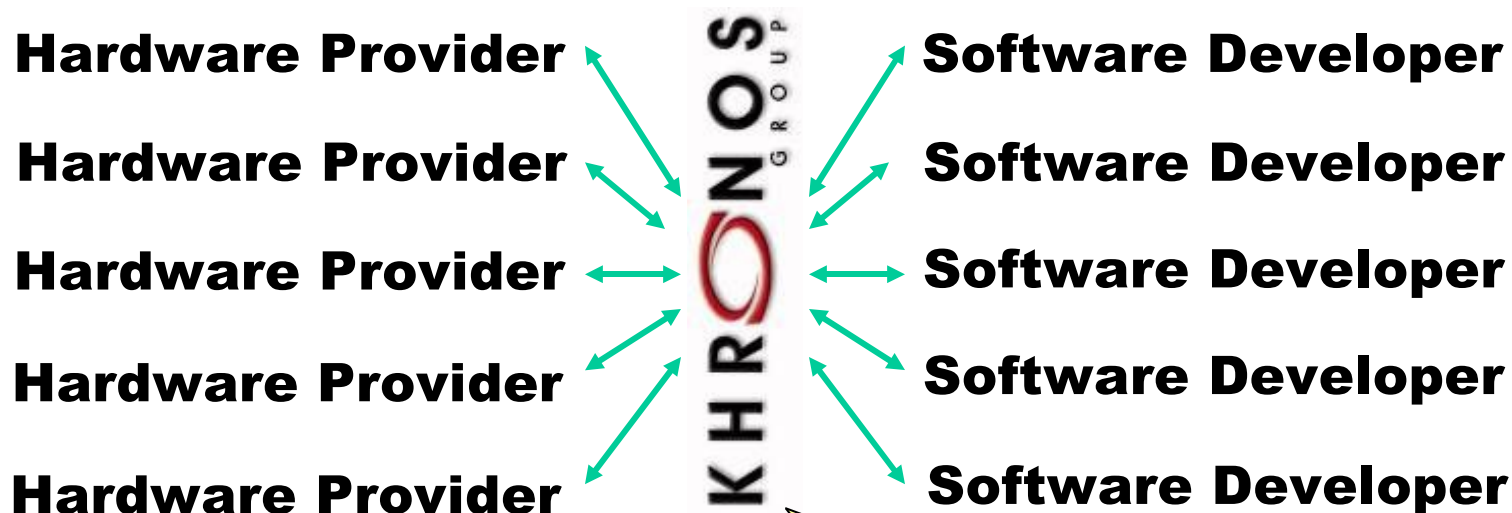
Rich Media Market Opportunity

- **Handhelds becoming capable of playing rich media**
 - New rich media features increase number of applications and users
- **Khronos API standards enable media acceleration**
 - Without standards market growth is slowed



Media APIs Enable Market Growth

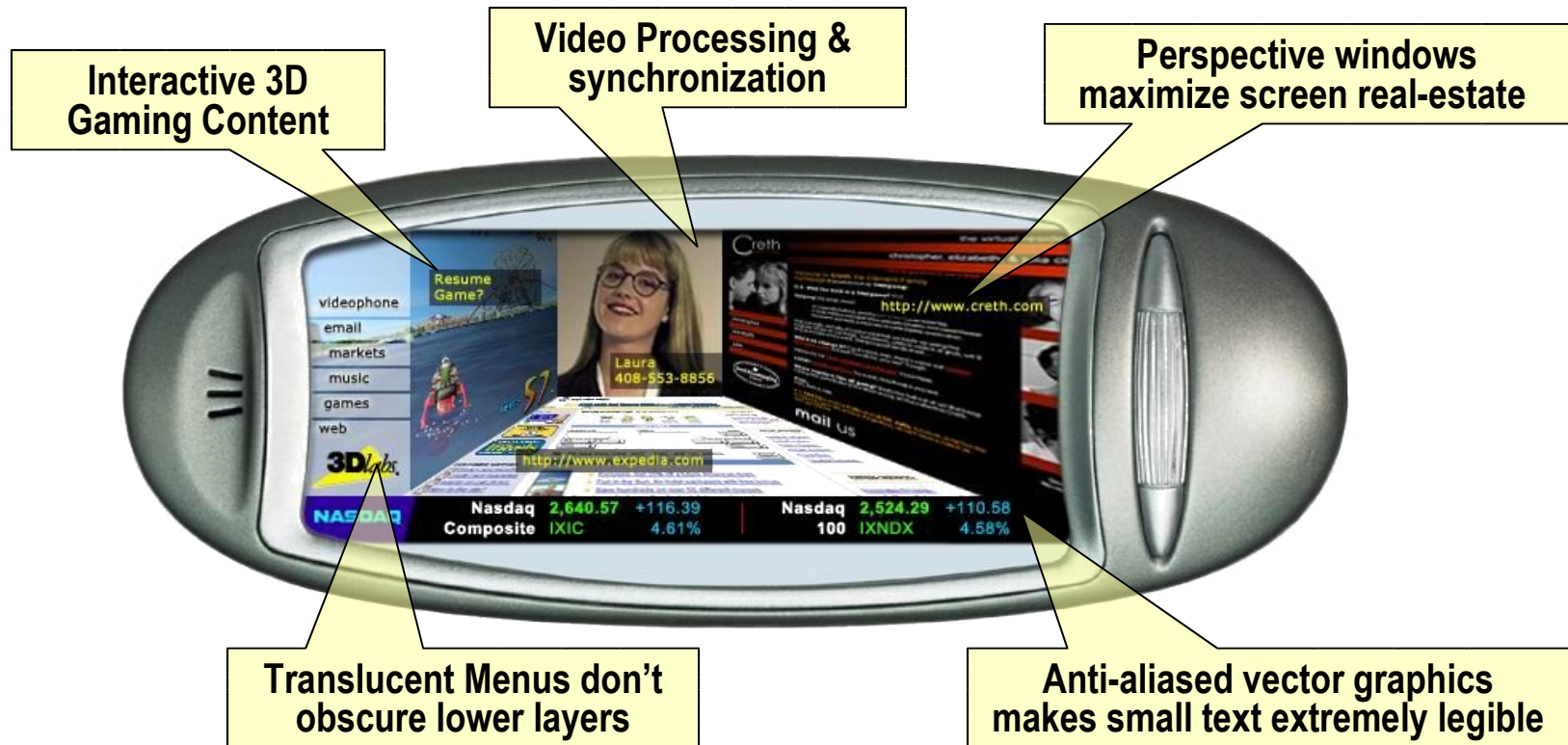
- **An API is an agreement between hardware and software worlds**
 - Enabling both - everyone wins
- **ISVs see reduced variability across multiple platforms**
 - More software can reach market faster at a better level of functionality and quality
- **Hardware vendors can accelerate many applications**
 - Adding value to their platform



An industry-standard media API
enables any software to run on any
conformant hardware

Small Screens Need Advanced Media

- **Smaller screens need more advanced graphics processing per pixel**
 - To make best use of restricted screen real-estate
- **Advanced graphics techniques provided by state-of-the-art media APIs**
 - 2D and 3D, anti-aliasing, multi-level compositing, video processing



Creating Open API Standards

Open Membership

Any company can join
Funded by membership dues

Open Standards

Royalty-free
Publicly available

K H R O N O S
G R O U P

Open Standard APIs for Embedded Rich Media Acceleration

Cross Platform

Enabling diverse handheld and
embedded markets

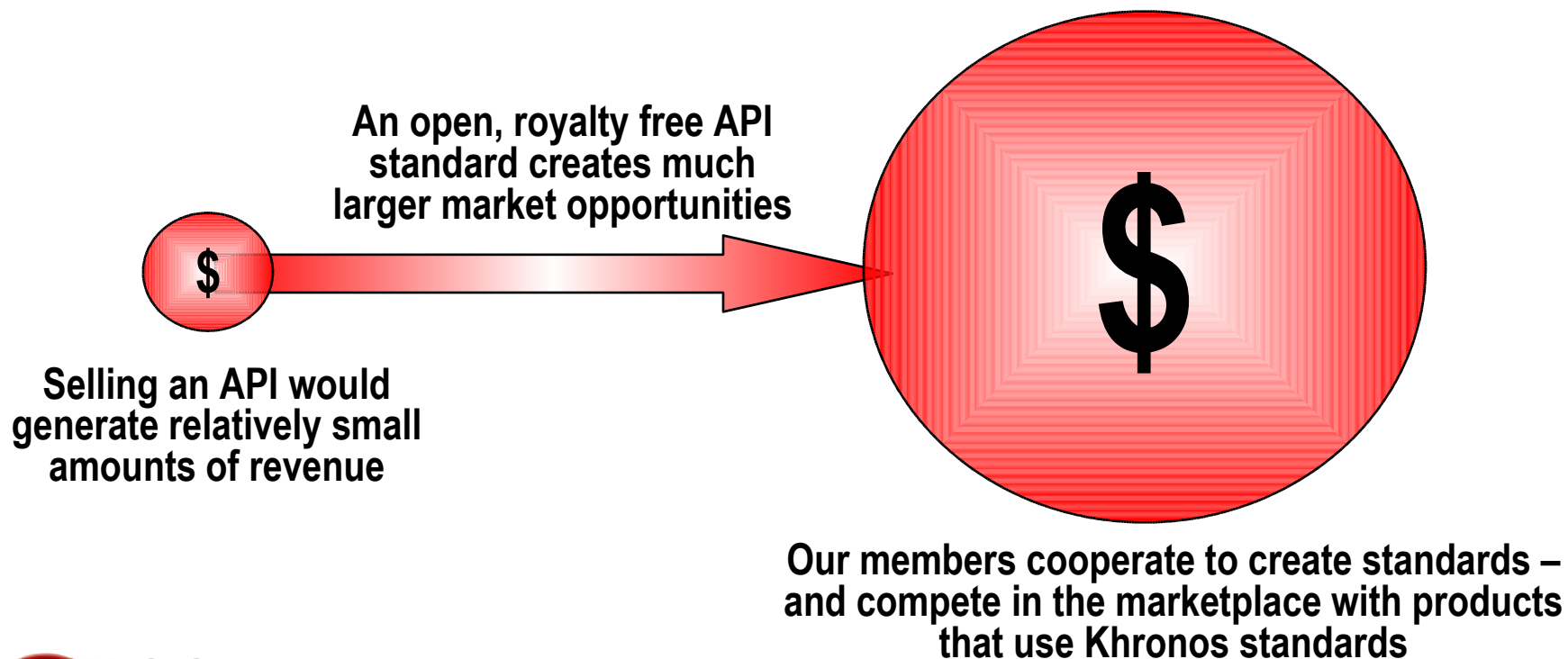
Creates Industry Momentum

Specifications, Conformance tests,
Promotion and Education

**Khronos has a PROVEN reputation for
the TIMELY creation of HIGH-QUALITY,
ROYALTY-FREE standards**

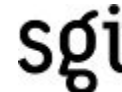
How Does Khronos Make Money?

- It doesn't!
- **Khronos is purely a non-profit organization**
 - Funded by member dues – to cover costs
- **Our members make money from selling PRODUCTS enabled by standards**
 - NOT trying to charge for the standard itself

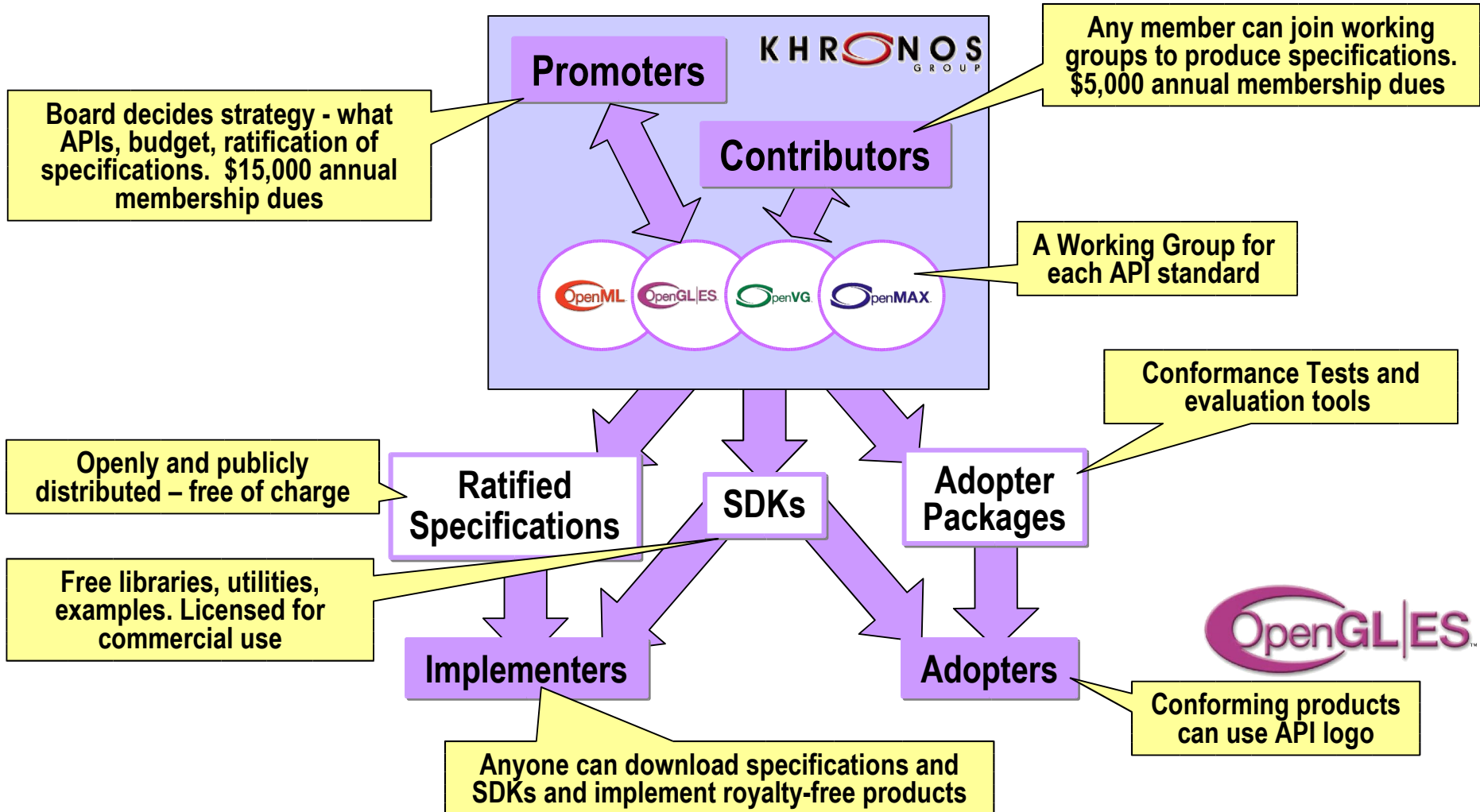




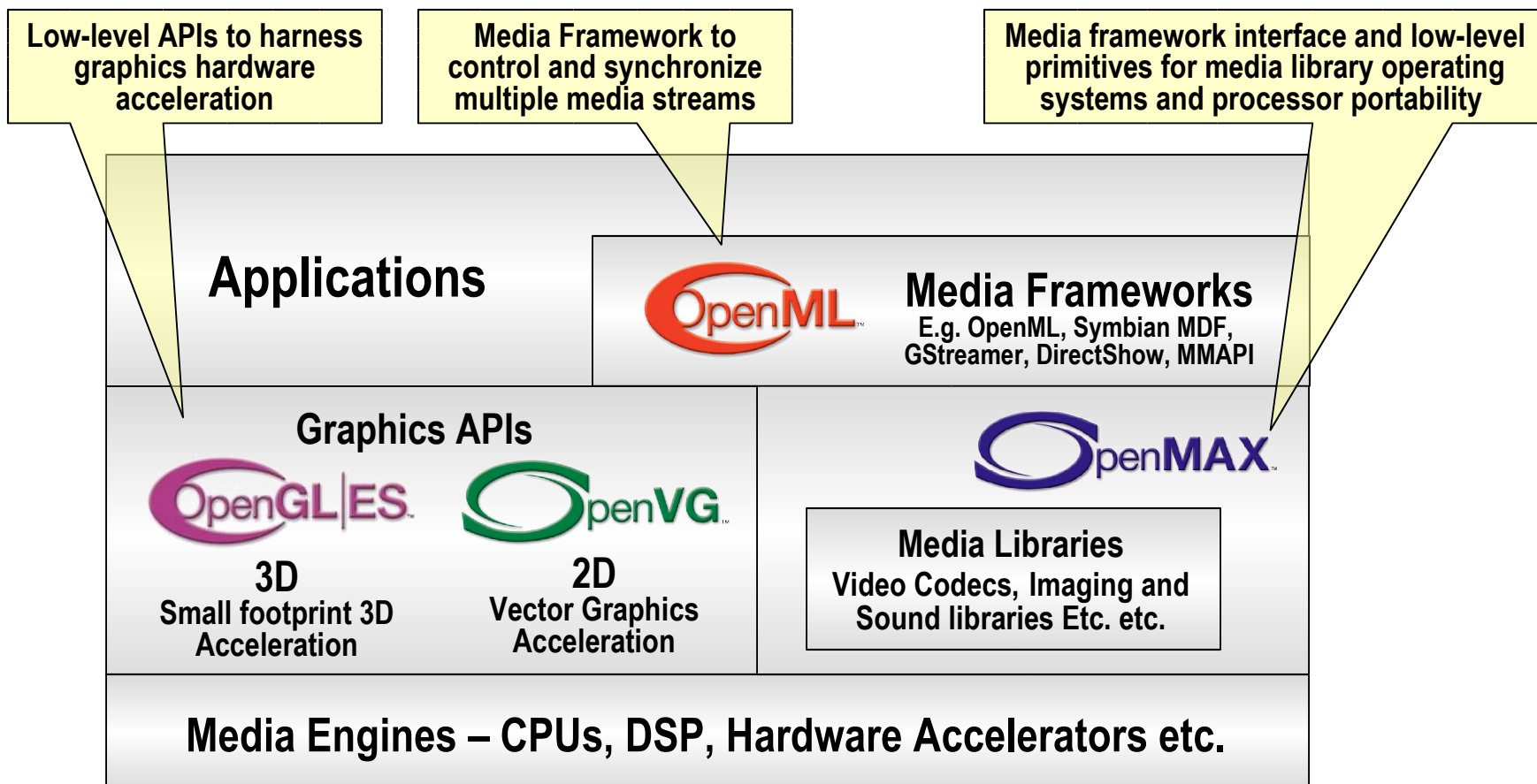
70 Companies creating media acceleration APIs



Khronos Participation Model



Khronos Media Acceleration APIs



Khronos APIs work together to enable an extensive media processing capability

Recent Khronos News

- **Khronos membership 70+ companies**
 - From all parts of the industry food chain
- **OpenGL ES 1.1 publicly released on schedule in August 2004**
 - To enable a new wave of 3D hardware accelerated cell phones
- **OpenVG entering public review**
 - Details on www.khronos.org
- **First OpenGL ES hardware accelerated cell phones beginning to ship**
 - Cell phone market is currently running at 500M handsets a year
 - Within 3 years there will be more OpenGL ES machines than Direct3D machines



The Nokia 6630 Symbian smartphone is now shipping and supports the OpenGL ES API

The Vodafone V602SH
- With full hardware OpenGL ES acceleration – in stores in Japan now



SK Telecom

P&C S3500

First GIGA Class 3 phone with OpenGL ES



**The Industry Standard for
Embedded 3D Graphics**

Increasing Cell Phone Functionality

- Mobile media capabilities sell more handsets

VisionGain Report: Wireless Gaming 2002-2007:

Currently **5M wireless game users in Europe** - by 2005 this number is set to grow to an astonishing **130M**

IDC Report: US Wireless Gaming Forecast Update 2003-2008:

Gaming will soon cross the chasm from early adopters to mass-market and grow to **34.7%** of the US' 190M users in 2008, resulting in **65M** games players.

3D Gaming



Nov'02: Nokia ships **50M** imaging phones in '03
Dec'03: **ALL** NTT DoCoMo **3G** phones
have imaging

Imaging



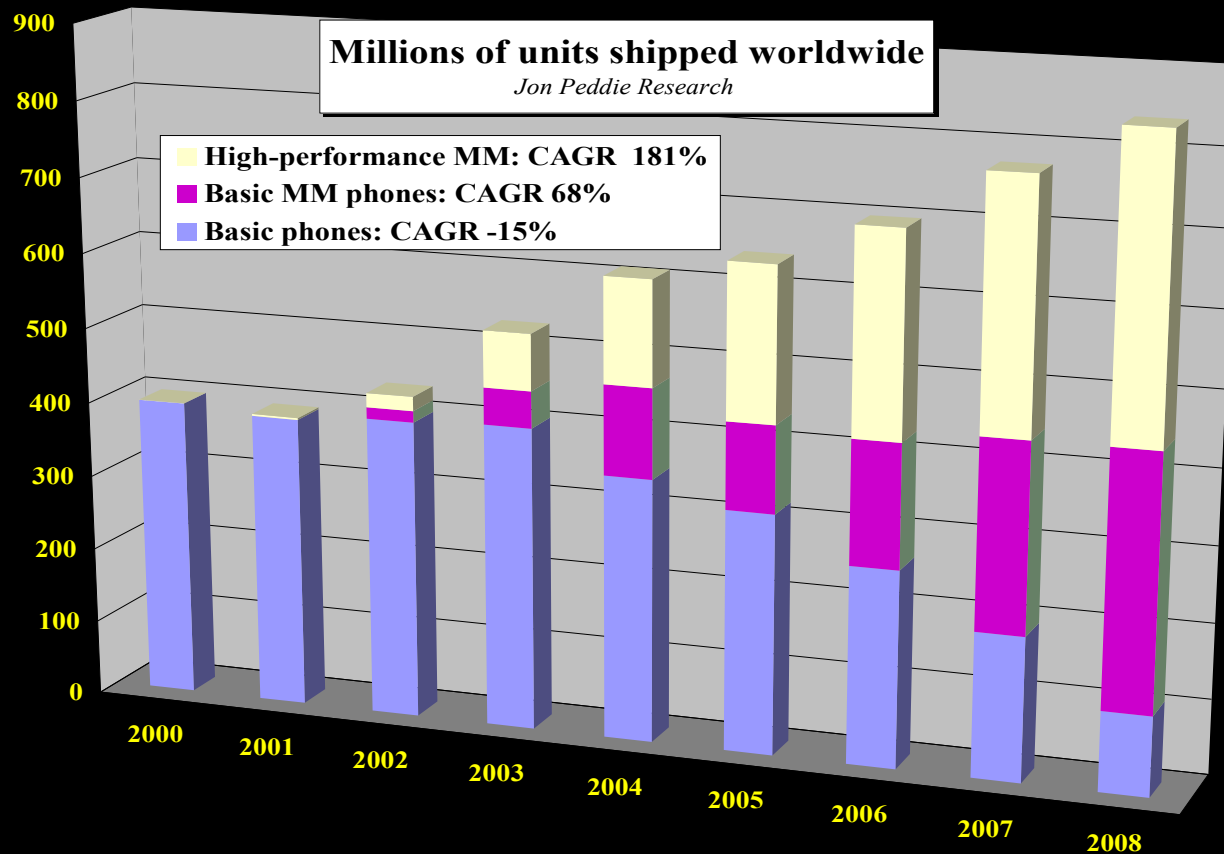
Video



Hundreds of Millions of Wireless Gaming Users?
What will they Play?
High quality 2D and 3D Graphics is Key

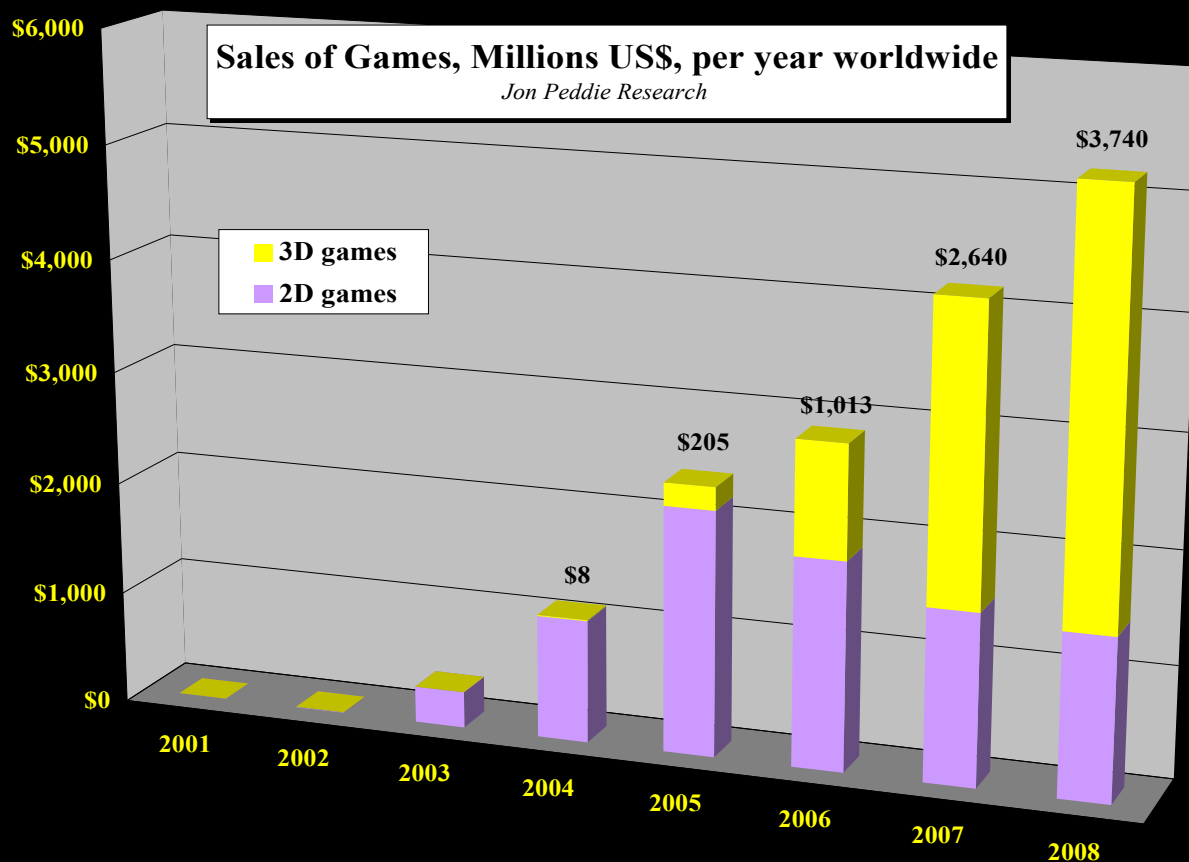
ARC Market Analysis 2003-2008:
Over **40 cellular operators worldwide** have launched mobile video services, thanks to technology advances, color screens, cameras, advanced media processors and increased memory storage....

Mobile Phone Market



Predictions

Handheld Game Market



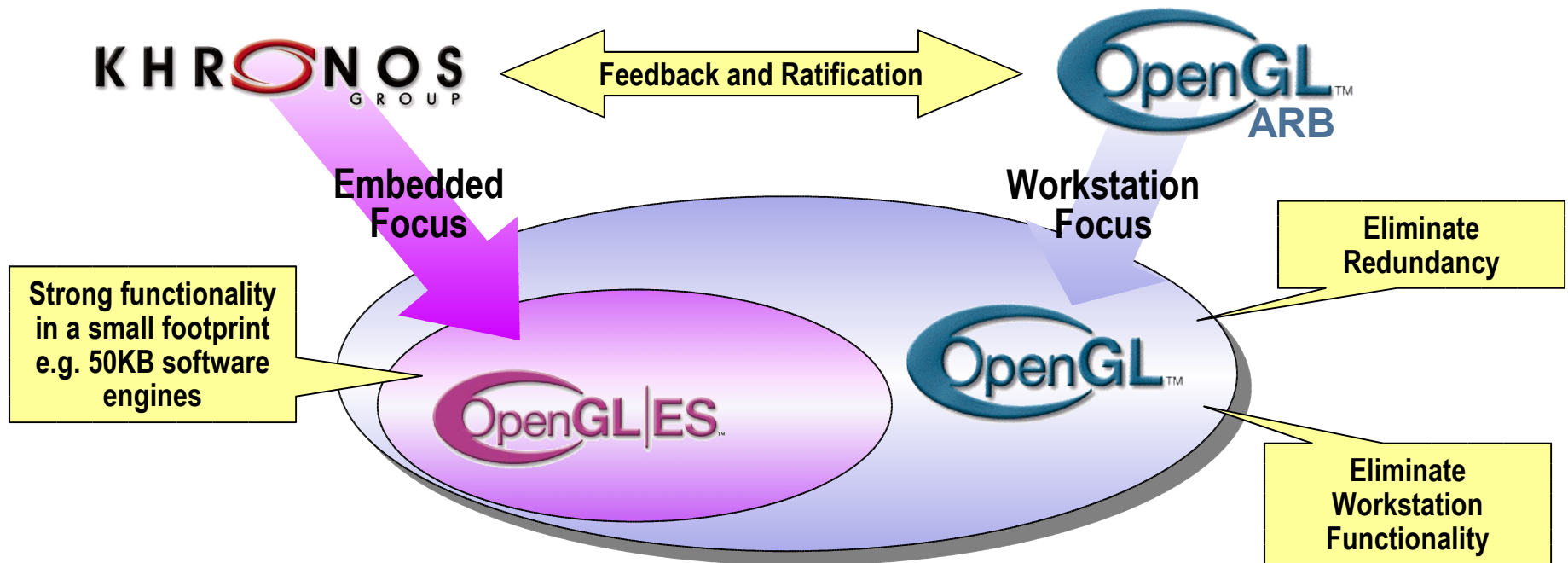
Predictions

Diverse Platforms Need 3D Graphics



OpenGL ES API Standard

- **Small-footprint subset of OpenGL**
 - Created with the blessing and cooperation of the OpenGL ARB
- **Powerful, low-level API with full functionality for 3D games**
 - Available on all key platforms
- **Royalty Free!!**



OpenGL ES Requirements

- Cell phone industry is the first major adopter

Hardware acceleration saves
90% of power



POWER

Enable games to easily
run on multiple platforms



CONTENT

PRICE



Low-cost chips and cores
Complete software implementation
at less than 50KB

QUALITY



High-quality processing per
pixel for small screens



OpenGL ES – Central to Mobile 3D

- Cross platform, low-level graphics API standard

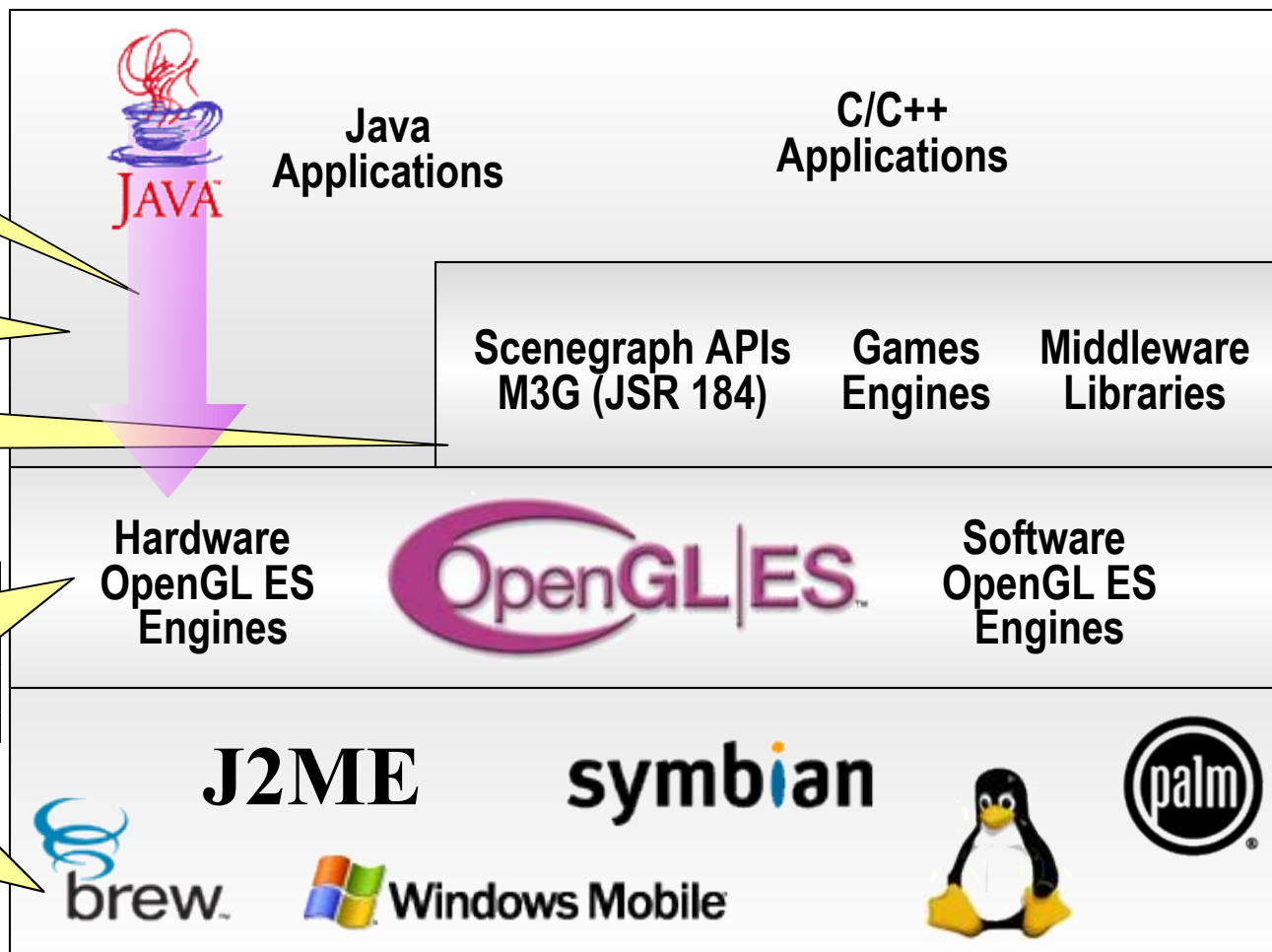
JSR 239
Defining official
Java Bindings to
OpenGL ES

Usable directly by
applications

Usable by higher
abstraction
libraries

“Close to the metal”
API provides
portability AND
flexibility

Brings advanced
2D/3D graphics to
a wide range of
platforms



Applications

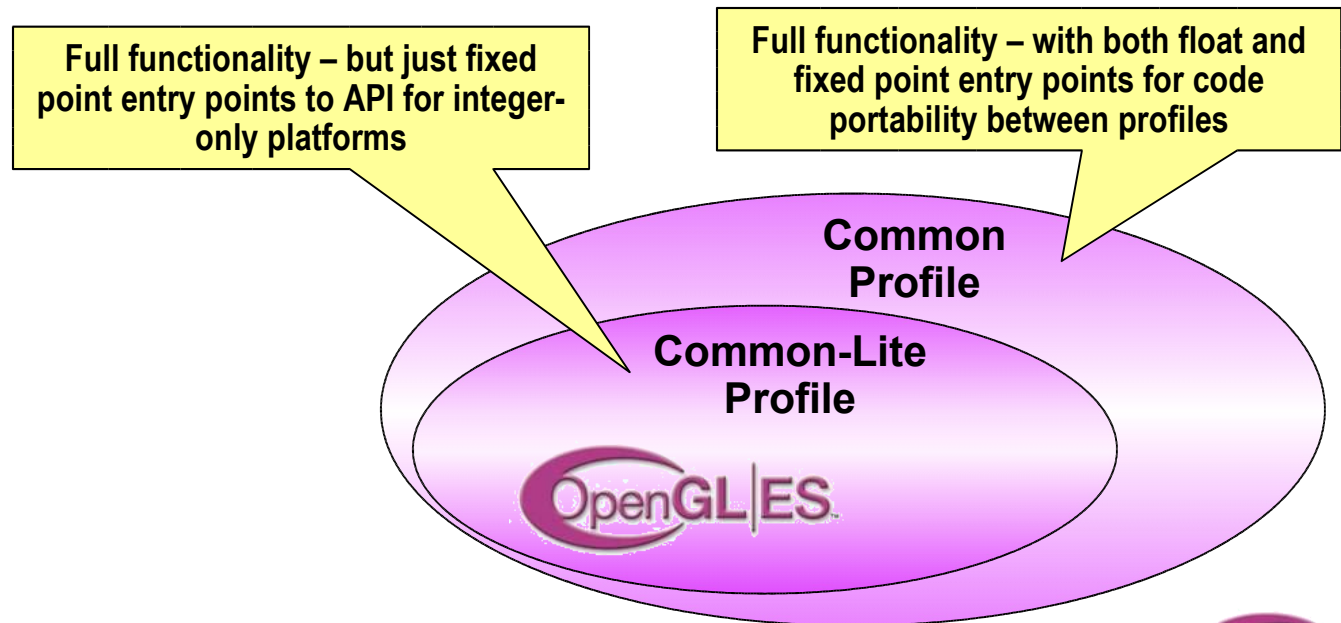
High-level
Graphics
Libraries

Low-level
3D Graphics
API

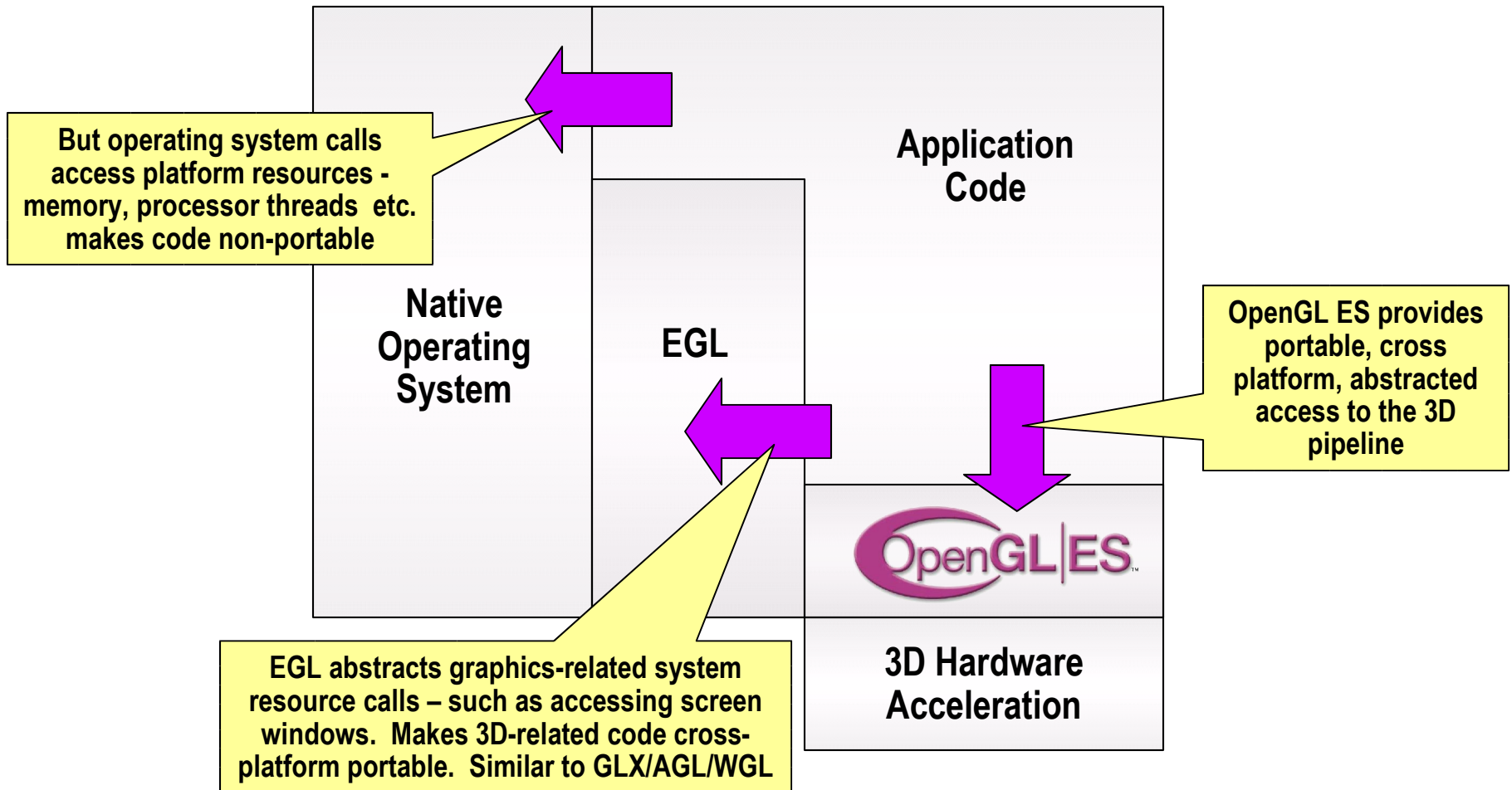
Operating
Systems

Fixed and Float Profiles

- **Support for high-volume devices systems with no floating point is key**
 - But need to prevent fragmentation between fixed and float applications
- **Common-Lite profile replaces all floating point calls with fixed point**
 - Enabling applications to use just 16.16 integer math
- **Common Profile is a proper superset of Common-Lite**
 - Has BOTH fixed and float versions of all entry points
- **Common-Lite applications run without modification on Common Profile**

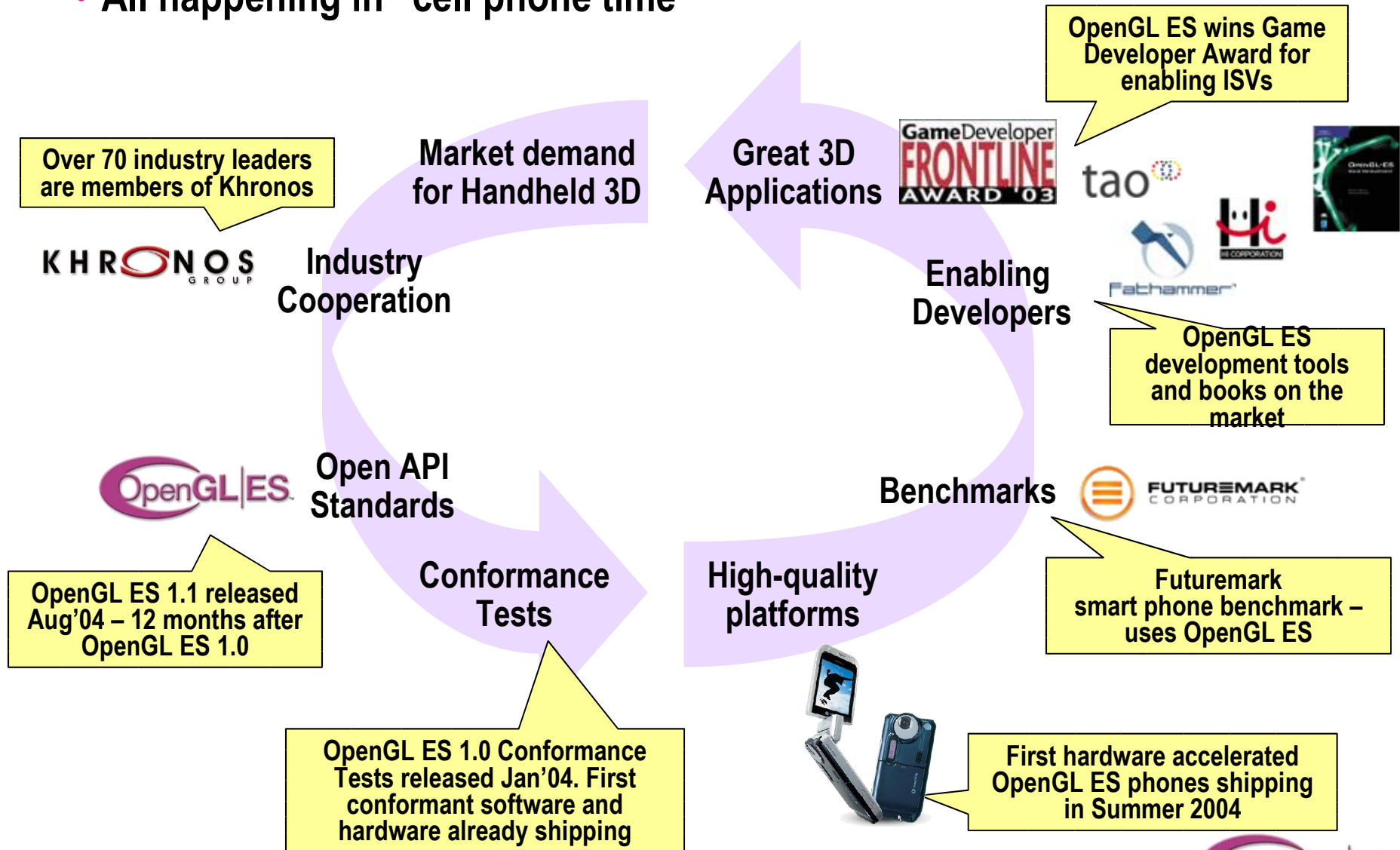


EGL – Increasing 3D Code Portability



Building the Graphics API Ecosystem

- All happening in “cell phone time”



OpenGL ES Adopters Package

- **Enabling Evaluation, Implementation and Testing**
- **Evaluate the API: fully operational OpenGL ES library**
 - Includes full Gerbera™ executable for Windows from Hybrid
- **Implementation Insights: open source sample implementation**
 - OpenGL ES layered over desktop OpenGL on Windows and Linux
- **Testing Functionality: source to Conformance Tests**
 - Only Conformant products can use the OpenGL ES Trademark
 - A peer-review formal process raises the testing bar relative to desktop OpenGL

**Reliable, cross-platform
graphics functionality!**



Reduces ISV porting
and support costs
across a wide diversity
of platforms

**ISVs SHOULD DEMAND CONFORMANT PRODUCTS!
LOOK FOR THE LOGO!**

Conformant OpenGL ES Products

- So far – many more in development



OpenGL ES in Action



Java MIDP1.0

Before OpenGL ES

MotoGP on
Accelerated
OpenGL ES



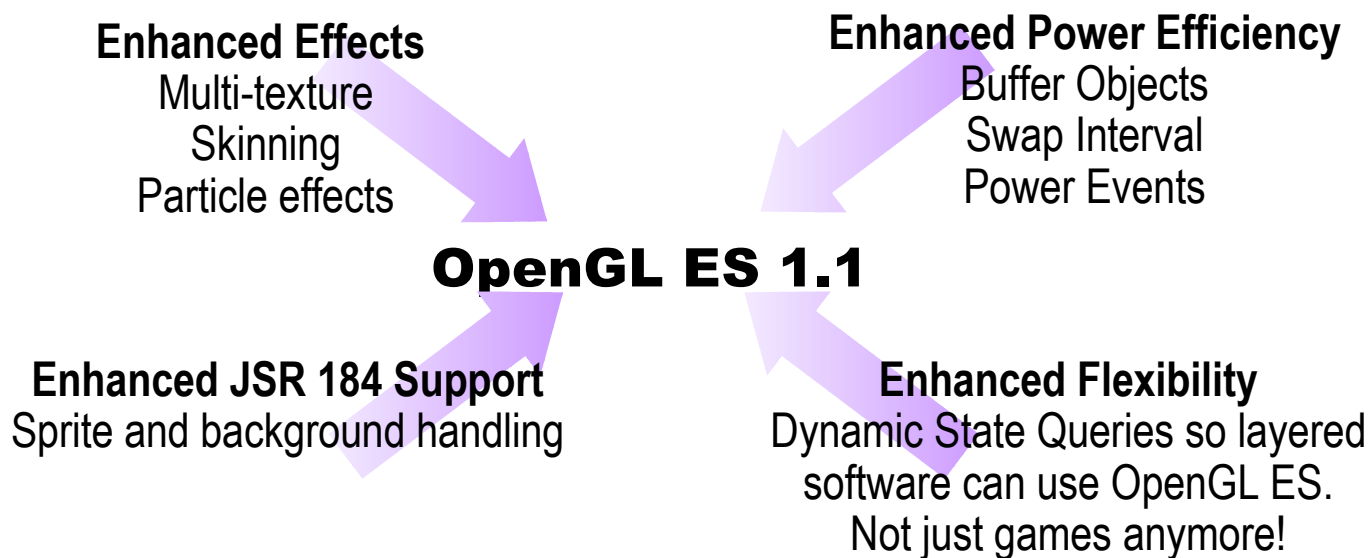
Nokia N-Gage

Increased visual quality, visual
effects, screen resolution and
frame rate – for less mW!!



OpenGL ES and EGL 1.1

- **Enabling new-generation, hardware enabled handsets**
- **Delivered on schedule – enabling and encouraging industry progress**
 - Khronos committed to annual API update at Siggraph last year
- **Backwards compatible with OpenGL ES 1.0**
 - A superset of OpenGL ES 1.0 - Common and Common-Lite profiles maintained
- **OpenGL ES 1.1 Conformance Tests in three months**
 - Formal peer review - sustaining API quality – vital for industry confidence and adoption



API Must Evolve at the Right Speed

Not too fast to prevent
widespread adoption

Fast enough to encourage and
expose new capabilities

OpenGL ES 1.0
3D running in
software on CPU



OpenGL ES 1.1
Enhanced 3D running on
fixed-function hardware



OpenGL ES 2.0
3D shaders running on
programmable hardware –



Previous API generations continue to be used and
deployed on diverse range of devices. OpenGL ES 2.0
does NOT obsolete OpenGL ES 1.0 and 1.1

Shipping
Products

KHRONOS
GROUP

2004

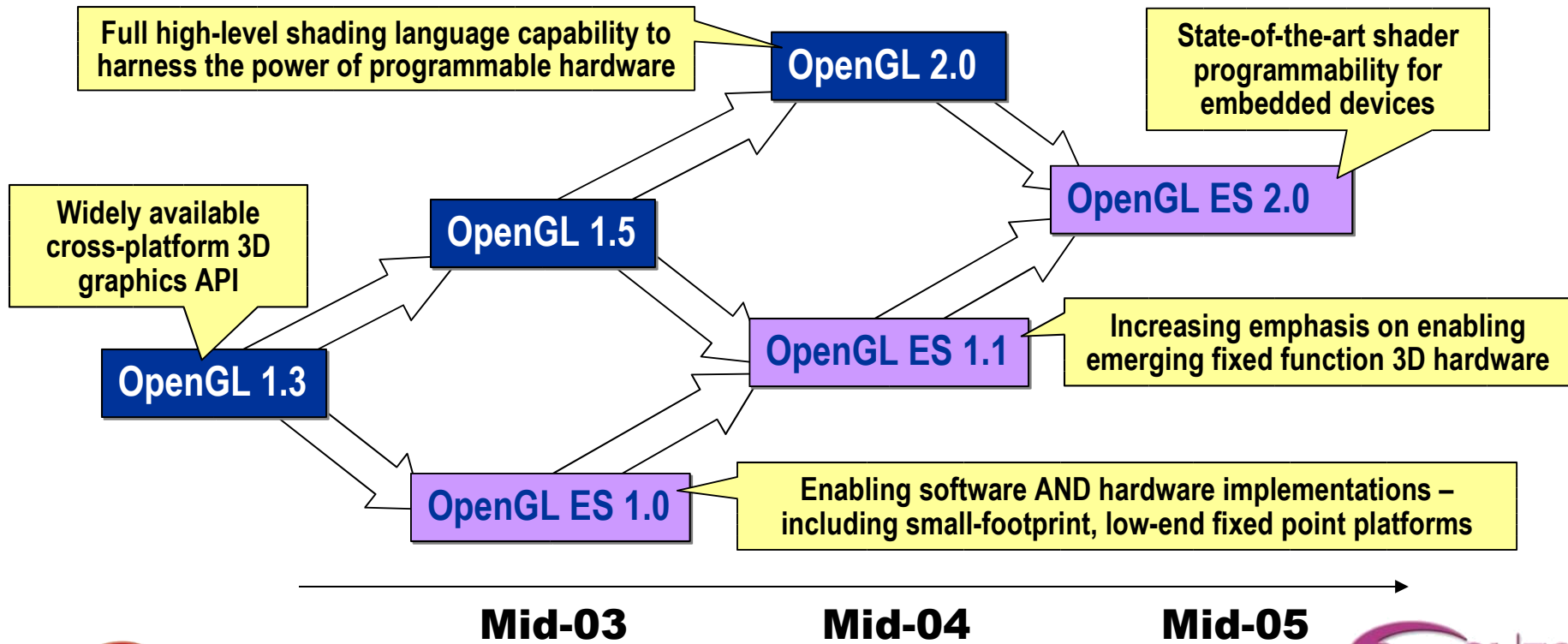
2005

2006



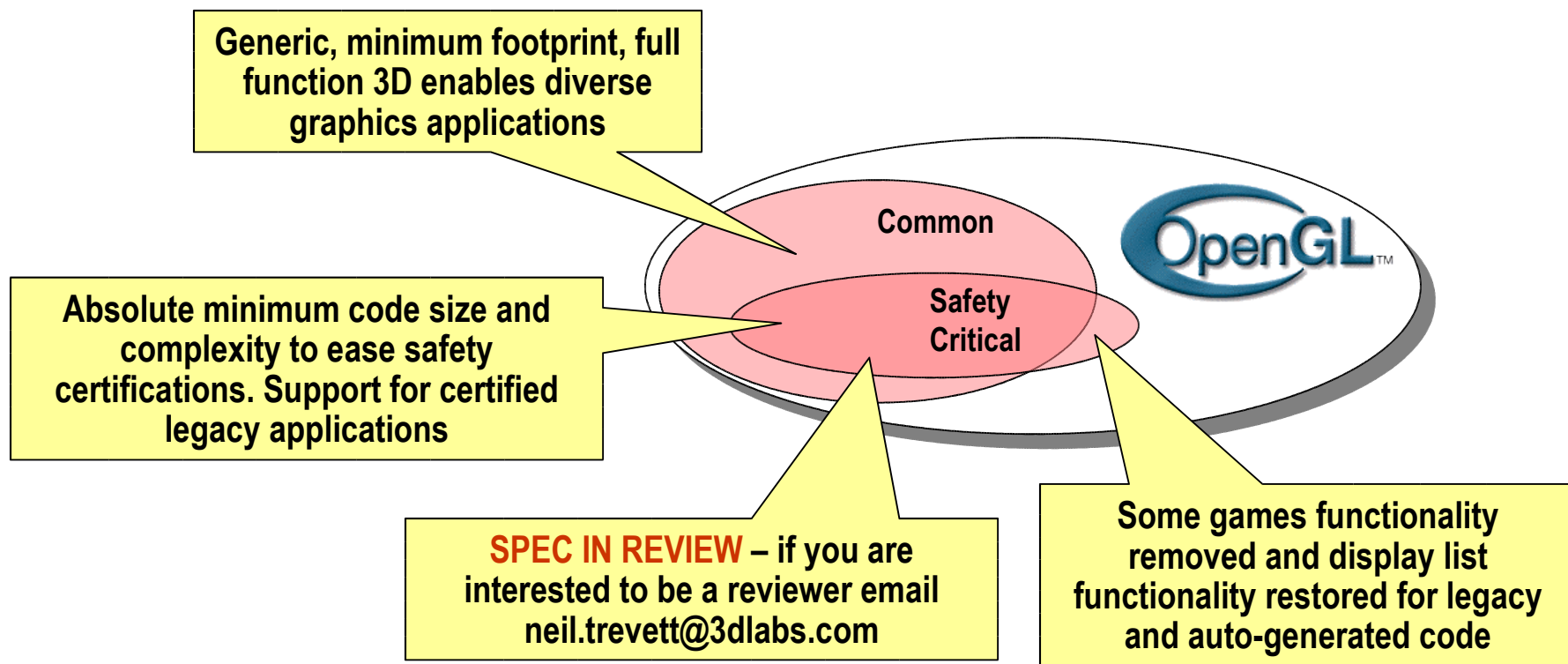
OpenGL ES Roadmap

- **Update OpenGL ES every year by default**
 - To expose rapidly developing handheld platforms capabilities
- **BUT ONLY introduce features with proven demand from ISVs or IHVs**
 - Guarding against unnecessary bloat
- **Track and adapt developments in desktop OpenGL**



Safety Critical Profile

- Targeted at avionics and automotive applications
 - Enabling OpenGL ES drivers that can be DO178-B certified
- Khronos Safety Critical Working Group in progress now
 - To produce profile specification in first half of 2005



OpenGL ES Coding Challenge

- The OpenGL ES Coding contest is now running!
 - Sample code and applications for OpenGL ES games, demos and screensavers
- \$100K in prizes to be awarded at GDC in March 2005
 - A license of dPVS, Hybrid Graphics visibility determination library (value \$75,000)
 - Borland C++ BuilderX 1.5 Mobile Edition - courtesy of Nokia (value \$8,000)
 - Subscription to JPR TechWatch (value \$2,500)
 - 3Dlabs Wildcat Realizm board (value \$1,500)
 - And more!
- See www.khronos.org/devu/opengles_challenge/



BITBOYS

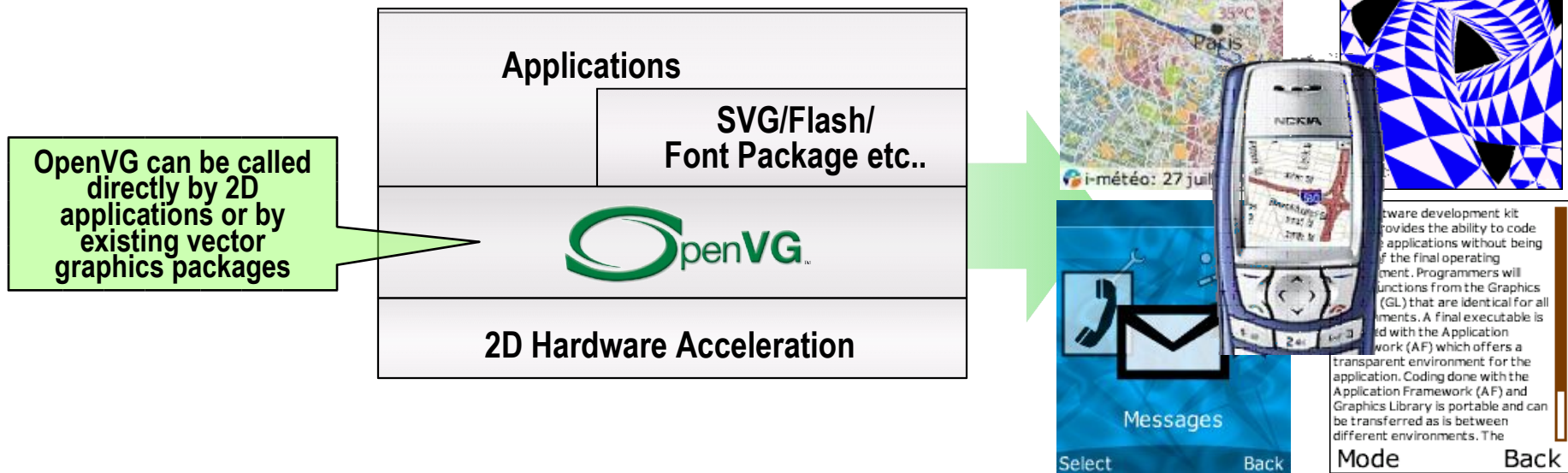




Accelerated Vector Graphics

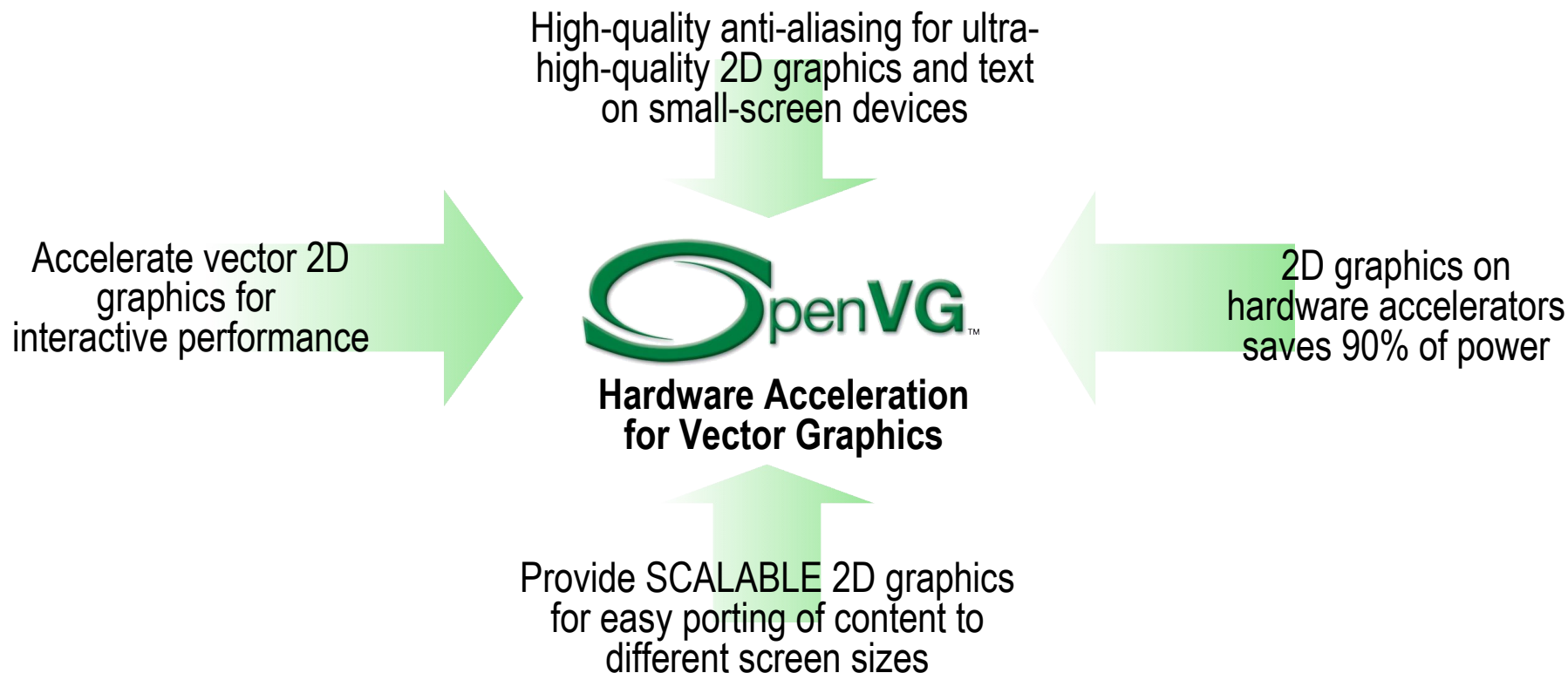
Strong Need for Vector Graphics

- **Many applications need low-level vector graphics primitives**
 - Portable Mapping and GPS applications, E-book Readers and text packages
 - Advanced user interfaces and screen savers
- **Many vector graphics formats in use**
 - Flash, SVG, PDF, Postscript, Vector fonts etc. etc.
- **OpenVG ACCELERATES existing formats – for the first time**
 - NOT a competitor to existing formats



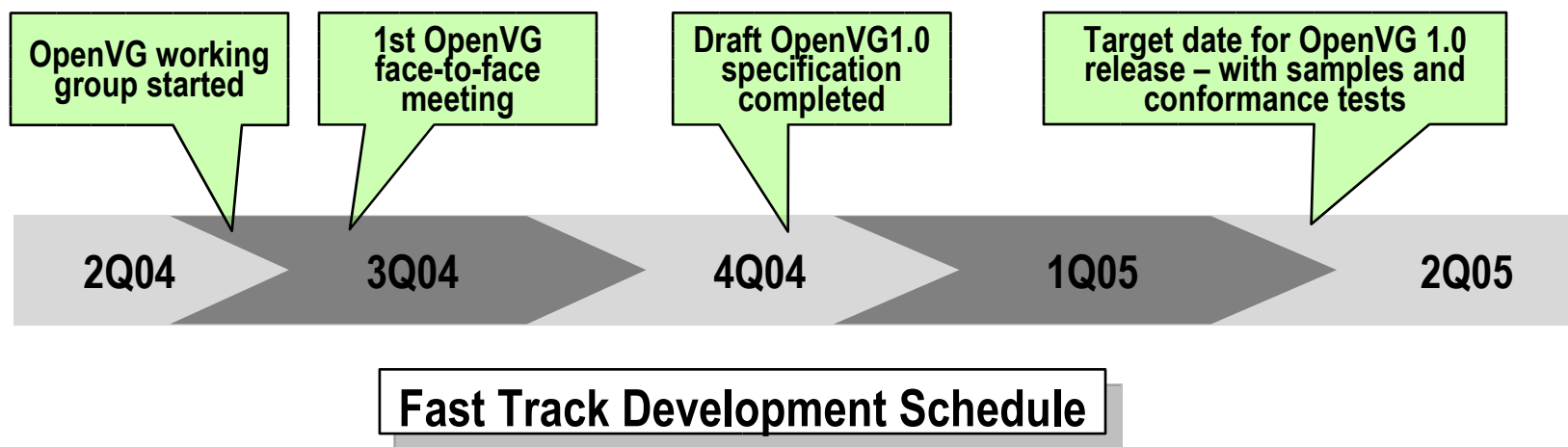
OpenVG – Accelerating 2D Graphics

- **OpenVG is a low-level API for 2D Bezier-based vector graphics**
 - With a focus on enabling hardware acceleration
- **Vector graphics acceleration brings high value to handheld devices:**



OpenVG Design Philosophy

- Provide a low-level hardware acceleration abstraction layer
- Place functions not expected in hardware in the near future into the optional VGU utility library
- Use OpenGL-style syntax where possible to make learning OpenVG as easy as possible for OpenGL developers
- Reference Path and Image objects by opaque handles - enabling hardware vendors to using their own preferred representations



OpenVG Feature Set

- **Core API**

- Coordinate Systems and Transformations
(Image drawing uses a 3x3 perspective
(or projective) transformation matrix)
- Paths
- Images
- Image Filters
- Paint (gradient and pattern)
- Blending and Masking

- **The VGU Utility Library**

- Higher-level Geometric Primitives
- Image Warping
- Animations

**Definition of path,
transformation, stroke and
paint**

Stroked path generation

Transformation

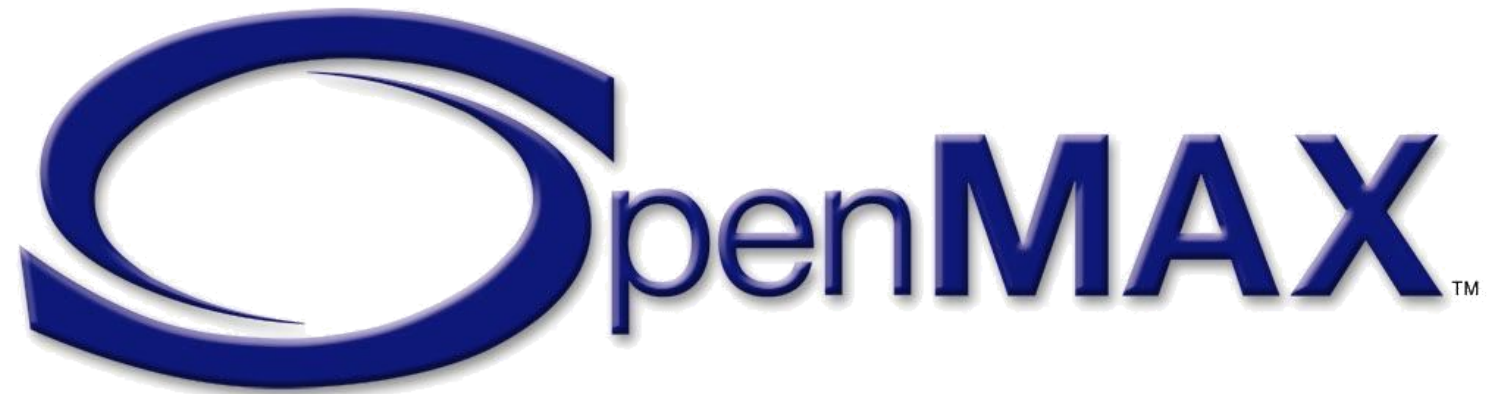
Clipping

Rasterization

Masking

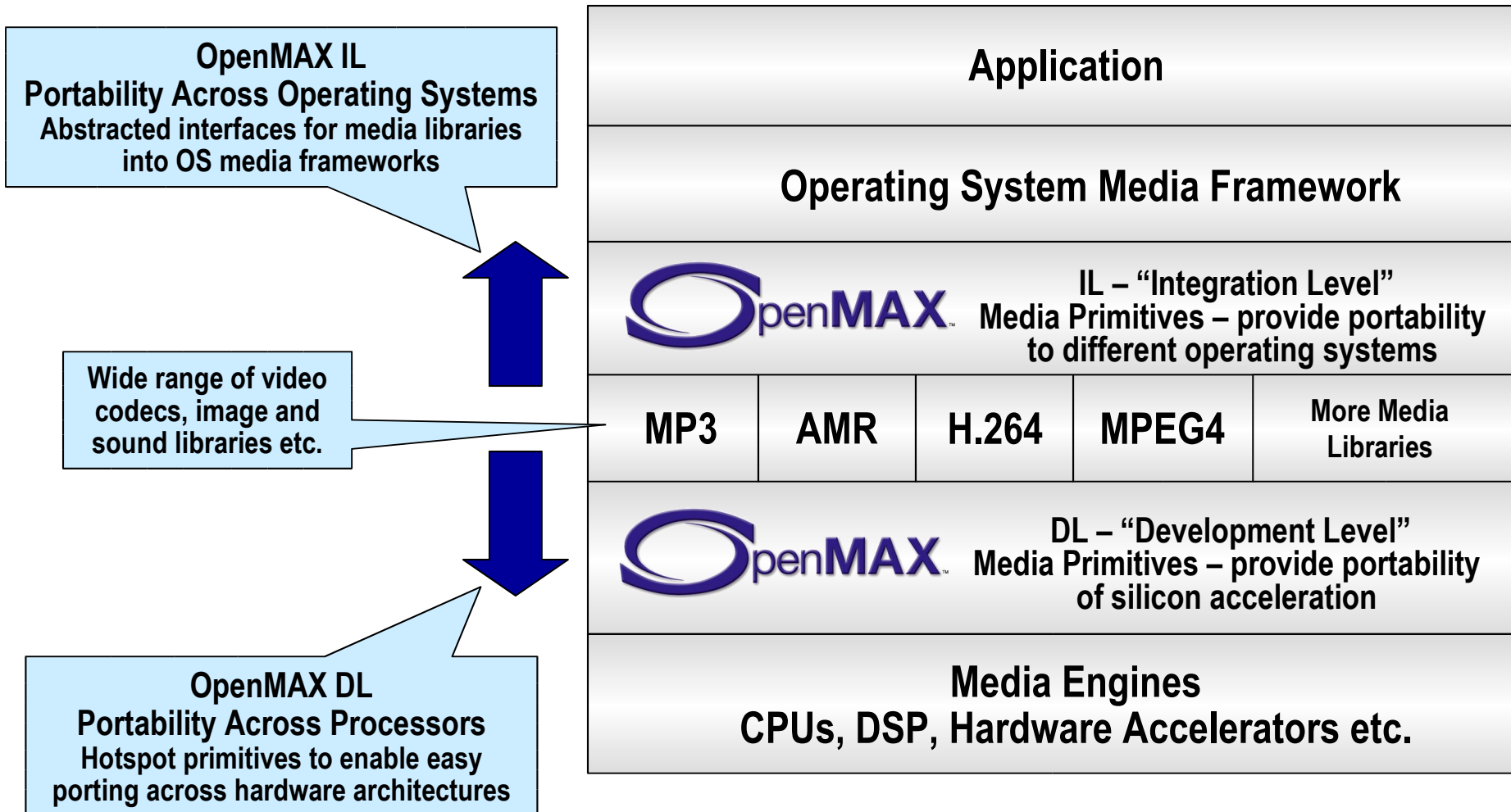
Paint Generation

Blending



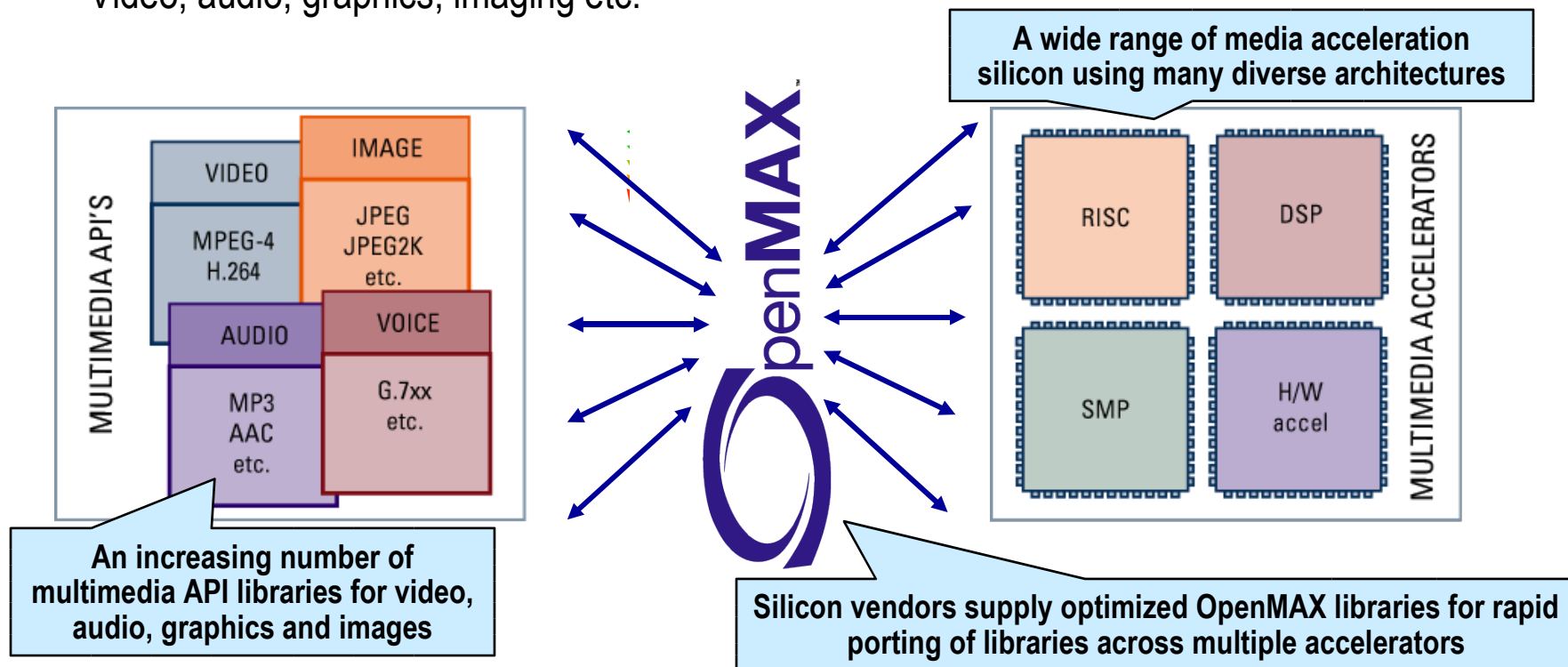
Media Library Portability

Complete Media Library Portability



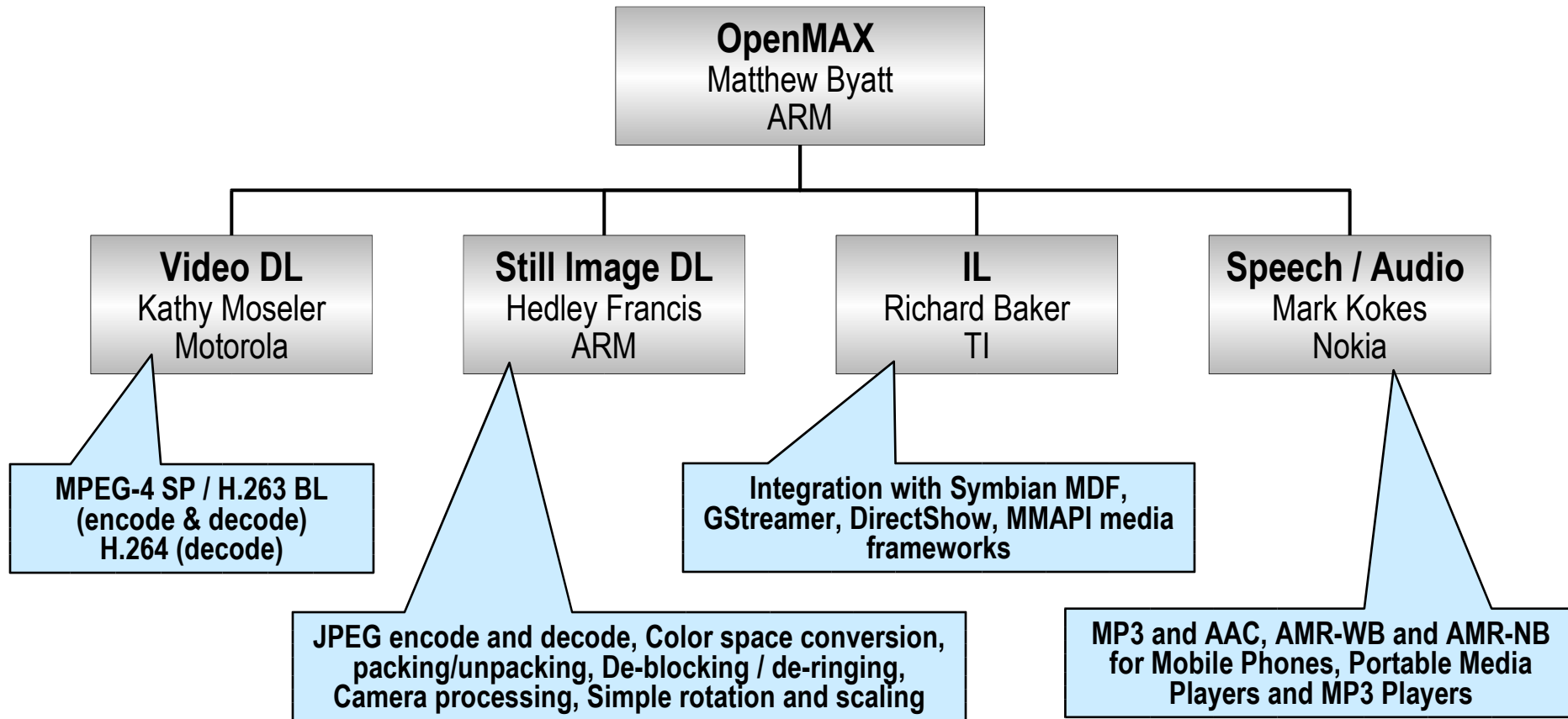
OpenMAX – Media Primitives

- **Combinatorial problem of hardware and software**
 - Media libraries are typically LATE to market and POORLY optimized
- **OpenMAX defines standard collections of media “hotspot” primitives**
 - To be implemented on multiple processors, platforms and architectures
- **Enables rapid PORTING and OPTIMIZATION of multimedia libraries**
 - Video, audio, graphics, imaging etc.



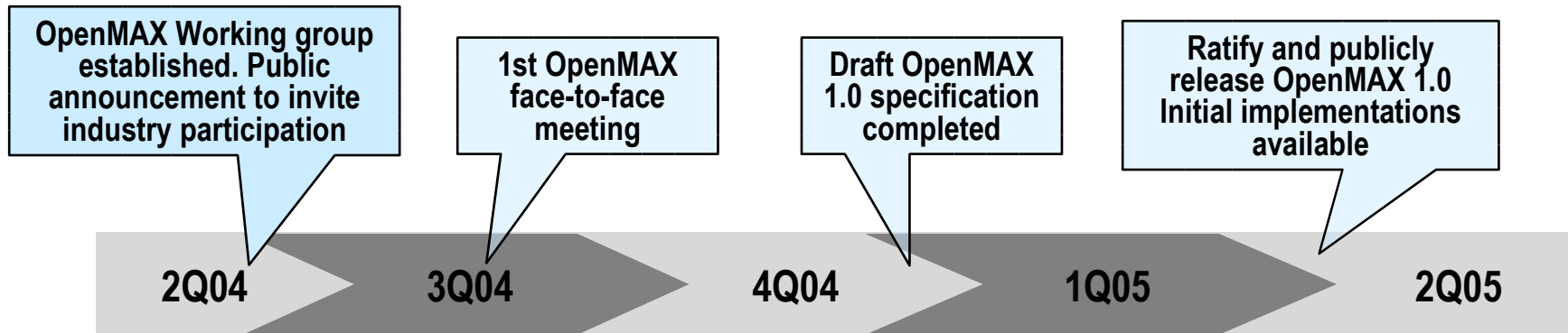
OpenMAX Technical Sub-groups

- **Market segment focused technical sub-groups**
 - Coordinated under a single working group
 - Chairperson for each sub-group



OpenMAX Working Group

- **Specification will be open and royalty-free**
 - Using Khronos reciprocal licensing IP model
- **Creating complete set of deliverables**
 - Specifications, implementations, conformance tests
- **Available on wide variety of architectures and operating systems**
 - To enable true media library portability
- **Encourage wide industry support and adoption**
 - Khronos strongly committed to promote this important new standard



Further Resources

- **www.khronos.org**
 - All presentations posted there
- **Public Forums**
 - Get involved in the Khronos community
- **Specification Reviews**
 - Sign-up for mailing list alerts for API draft reviews
- **DevU courses around the world**
 - Free full day educational courses
 - Details on www.khronos.org/devu/index.html
- **We welcome enquiries from companies interested to join Khronos**



Any Questions?

